# MATH 602: APPLIED STATISTICS

**( Winter 1999 )**

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**TEXTBOOKS:** (1) Engineering Statistics by D. C. Montgomery, G. C. Runger and N. F. Hubele (this is the primary textbook).

(2) Statistical Case Studies for Industrial Process Improvement" by V. Czitrom and P. Spagon (this is the secondary textbook).

**SOFTWARE:** MINITAB for Windows, Release 12.

**OBJECTIVES AND GOALS:** The students will be exposed to basic concepts and techniques in applied statistics. After a brief review of basic probability and statistics, applied statistics topics such as Analysis of variance, design of experiments, linear regression analysis, and statistical process control will be covered. Students successfully completing the course will have adequate understanding of these basic topics in applied statistics and will be able apply them in practice. Several mini class projects and a detailed term project will further strengthen the students' understanding of the concepts in applied statistics.

The statistical software MINITAB will be extensively used throughout the course. The statistics laboratory manual contains a number of experiments using MINITAB. These and other projects involving the use of MINITAB will be given in the form of homework problems. This will give more exposure and understanding of the software. We will be using a ***lot of practical data*** to illustrate the ideas and concepts in this course. You are highly encouraged to use data from your field (with appropriate permission from your work, if applicable) in your class projects. One of the important ways to motivate the current students is to discuss the *former* students' class projects. Hence I would like to use your class projects in the future. Where it is necessary, you may want to indicate the confidentiality of the data. These projects will be discussed without presenting the data.

## TENTATIVE SYLLABUS

[**NOTE:** As you see from the description of this course in the catalogue, you are assumed to have been exposed to basic concepts in probability and statistics in your undergraduate curriculum. Hence, we will review ONLY the relevant materials needed for the topics in Lectures 3-11, in the first two lectures. Essentially Chapters 1 through 5 (with some sections deleted) in the (primary) textbook will be presented in a condensed form in the review part. Supplementary notes will be handed out and problems will be assigned for homework periodically. Some of these will be collected for grading].

**LECTURES 1, 2 and if needed first half of LECTURE 3**

What is Applied Statistics? Applications in various fields; what is statistics? What is probability? Relationship between probability and Statistics; **Review of Probability and Statistics-** Here only the basic concepts from probability and statistics that are very essential for understanding the topics in this course, will be reviewed. Specifically we will review the following: Basic Statistics; Data analysis including the concepts of data, samples, sampling techniques, graphical analysis; Sample space; Descriptive statistics; These concepts will be illustrated through practical data; Introduction to MINITAB, a statistical software package; Definitions of Probability, events, and sample space; calculation of probabilities; rules of probability; set theory; conditional probability; and independent events; random variables; probability functions; some useful and important discrete and continuous distributions such as binomial, Poisson, normal, student's t, chi-squared and F; Central Limit theorem; illustration of CLT; Introduction to inferential statistics: estimation of key parameters such as mean, variance and proportion. Here both one and two-population cases will be reviewed. Introduction to test of hypotheses: basic concepts, setup of hypotheses, testing procedures, will be reviewed. The use of MINITAB in the statistical analysis. Lay groundwork for testing more than two populations.

**LECTURE 3** (Chapter 5, section 5.8 plus supplementary notes)

Introduction to Analysis of variance (ANOVA); basic concepts in ANOVA; One-way ANOVA; two-way ANOVA; analysis of factor effects; the use of MINITAB in ANOVA techniques; a number of illustrative examples.

**LECTURES 4-6** (Chapter 6 + supplementary notes)

Building models; Simple Linear Regression Models: Introduction; model and parameter estimation; tests of hypotheses on the parameters; the use of MINITAB; a number of illustrative examples.

Introduction to Multiple Linear Regression Models; Matrix approach to Least squares problem; estimation and tests of hypotheses about the parameters of the model; The use of MINITAB; a number of illustrative examples.

Continuation of Multiple Linear Regression Models; indicator variables; variable selection methods; model transformation; the use of MINITAB; a number of illustrative examples.

**LECTURES 7-10** (Chapter 7 + supplementary notes)

Introduction to design of experiments; major steps in DOE; basic concepts in DOE; selection of response variables and factors; these concepts will be illustrated through a number of practical examples; Basic DOE: Completely randomized design; randomized block design; and Latin square design; analysis of main effects and interaction effects.

Introduction to Factorial experiments; basic concepts in factorial design; analysis of $2^2$ and $2^3$ factorial designs; algorithms for computing the main effects and interaction effects; analysis of various effects; discussion of some selected case studies.

More factorial designs; $2^4$ factorial designs; analysis; blocking; More applications of factorial designs; fractional factorial designs, resolution; Taguchi's design matrices; case studies; Response surface methods and designs.

**LECTURE 11** (Chapter 8 + supplementary notes)

Statistical Process and Quality Control: Introduction and basic concepts; various control charts; process capability.

**LECTURE 12:**

## COURSE GUIDELINES

The tentative schedule of topics to be covered in this class is given separately. It is highly recommended that you go through the topics in advance to get an idea of what we will do in the next class. The students are encouraged to participate freely in the class by asking questions. I personally feel that this creates a rich intellectual atmosphere in the classroom.

**GRADING PROCEDURE:** The course grade is based on **Assignments (75%)**, and **Term Project (25%).**

**I. Assignments:** Assignments are in the form of traditional homework problems, mini projects, and report writing on selected case studies taken from the second text book.

**a. Homework problems:** Homework is an important part of your course work. This will help you to understand the concepts and apply them in practice. These problems will be assigned to you periodically and **some selected** ones will be collected for grading. It is expected that you work these problems on your own and hand in your solutions and not others. We will be using MINITAB software extensively in the course and hence you can use the software in solving the problems. There will also be assignments based on MINITAB software, which you will be asked to submit for grading.

**b. Mini-projects:** The subject, Applied Statistics, is best understood by applying the tools and techniques (that you have been exposed to in the classes) in practice. Hence, you will be seeing a number of min-projects that require you to identify and understand the basic statistical concepts. These projects will be given to you periodically and will be collected for grading.

**c. Report writing:** The second textbook dealing with case studies from industries contains a number of interesting and practical examples. We will be discussing some selected case studies to further enhance the understanding of the applied statistical concepts. You will be periodically assigned some case studies from this book (that has the data disk) for doing statistical analysis. The written report should (a) include Minitab attachments, (b) be very well written (see class lectures for the specifics) summarizing in your own words, and (c) have answers to specific questions (if asked). You are highly encouraged to go over <u>all</u> the case studies during the course. This will also give you an idea for your term project for the course.

**II. Term Project**: This is a detailed project involving data and appropriate statistical analysis. Because of the limited time in the quarter, you will be asked to submit a one-page proposal of what you plan to do for your term project by **sixth** week. Upon approval of the plan, you will have to submit the completed project no later than **MONDAY of the TWELFTH** week. If you fail to submit a one-page proposal, you risk the possibility of your project not meeting the requirement of a "term project" and may result in 0 point for the term project. Your project should involve analysis of nontrivial data set using the techniques seen in the class. Ideally, your project should be taken from your work environment or an avocation that is meaningful to you. Note that your data set should be large enough that you can use several of the tools we discuss, but should be small enough so that you can complete the project within the allotted time (see below for details on the term project).

All project assignments (whether they are mini or term) should be submitted in **duplicates**. [**Note:** No need to submit traditional homework problems or Minitab output in duplicate]. One copy will be returned to you with comments and grades. I will retain the other copy. The final project should include a disk containing your data and MINITAB files. If you are handling confidential data, you should seek your employer permission.

All assignments should be handed in on time and there is no exception to this. Failure to do so will result in zero point. Cheating (including joint consultation with fellow students or copying fellow students' solutions) in any form will not be tolerated and will result in a Failure grade. Detailed instructions to students and course coordinators (who are responsible for off-campus students) are given in the handout containing Lecture 1 materials. You are advised to go through these carefully.

My office hours will be as follows:
**Monday, Wednesday, and Friday: 1 - 2pm**
**Thursday: 5:00 - 5:40pm**
**Other times:** by appointment.

You are highly encouraged to contact me via E-mail, as it is the most convenient, least expensive and highly efficient way of communicating. I check my E-mail very regularly all days and will reply ASAP.

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